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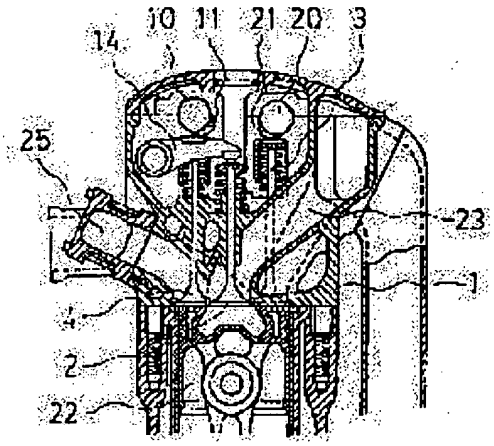
(54) VARIABLE COMPRESSION RATIO ENGINE



(57)Abstract:
PURPOSE: To make excellent startability and a combustion state at the time of light load and realize high output.
CONSTITUTION: A cylinder head 1 is provided with first and second intake valves 2, 3; an exhaust valve 4; and first and second cam shafts 10, 20. The first intake valve 2 and the exhaust valve 4 are operated by means of the first cam shaft 10, and the second intake valve 3 is operated by means of the second cam shaft 20. The second intake valve 6 can delay the time of closing by rotating the second cam shaft 20. At the time of high load, the closing time of the first and second intake valves 2, 3 is made to be 20°-91° before the bottom dead point of a piston, and the ratio of compression is decreased, and high output is realized. At the time of light load, the closing time,of the second intake valve 3 is delayed, end the ratio of compression is increased, and startability and a combustion state are made excellent.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the adjustable compression ratio engine with which a compression ratio is replaceable with a service condition.
[0002]

[Description of the Prior Art] The compression ratio of the conventional direct injection diesel power plant has many which are set as the 15 to 17 neighborhood. This is a compression ratio required in order to secure startability and the good combustion condition at the time of a light load (combustion out of which ****** containing HC and others does not come). And the closing motion stage of an inlet valve is set so that this compression ratio can be obtained.
[0003] If a compression ratio is determined, the cylinder internal pressure in the compression end of the engine will be decided, and the cylinder internal pressure at the time of ignition and explosion will also be decided. The permission maximum cylinder internal pressure was decided with the engine, as a compression ratio is high, the cylinder internal pressure in a compression end becomes higher, therefore the difference of this cylinder internal pressure and the permission maximum cylinder internal pressure decreases, and it has become the big factor in which this obstructs the high increase in power of that engine.
[0004] If it carries out from a viewpoint of combustion efficiency or a high increase in power, the 11 to 13 neighborhood of a compression ratio is desirable. If the axial mean effective pressure in which the implementation the case of a compression ratio 17 and in 12 is possible as an example is shown, it will become as it is shown in the following table.

the unit of the pressure in an upper table -- kgf/cm2 it is . Now and permission maximum cylinder internal pressure Pmax <=150 kgf/cm2 If it carries out, in the case of a compression ratio 17, axial mean effective pressure will be 21 kgf/cm2. Although remained, in the case of a compression ratio 12, axial mean effective pressure is 34 kgf/cm2. It becomes possible to carry out. . That is, a high increase in power is possible.
[0005] However, since it is conditions absolutely to acquire good startability and the good combustion condition at the time of a light load, the present condition is having set the compression ratio as the 15 to 17 neighborhood at the sacrifice of a high increase in power.
[0006] Although this is the same also in a gasoline engine and he wants to set a compression ratio to 11-13 as well as a diesel power plant from on combustion efficiency (thermal efficiency), in order to prevent knocking at the time of a heavy load, the compression ratio is set as 8-10. Therefore, specific fuel consumption is bad and is CO2. There is a problem that there are many yields.
[0007] Conventionally, the Miller cycle engine with which a thermal efficiency improvement of a diesel power plant, the low compression ratio as a way stage of exhaust air emission reduction, and a high expansion ratio are obtained is an effective means. There is a method which misses an

intake pressure in early stages of a compression stroke at a Miller cycle engine by making into ****** the method which intercepts the flow of inhalation of air in the middle of and inlet valve like an inhalation-of-air line of an inlet valve already like closing. However, since an effective compression ratio would fall if it is mirror cycle actuation as mentioned above in an engine low speed and a low load region, there was a problem that ignition was not stabilized.

[0008] There is a Miller cycle engine like a degree as a policy which solves this problem. Drawing 14 is the conceptual diagram of a Miller cycle engine, and an inlet valve 60 is opened and closed through a timing gear, a cam shaft, a tappet, a push rod, and a rocker arm from the crankshaft which is not illustrated. The new valve 62 is formed in the middle of the upper path 61 of an inlet valve 60, an engine rotational frequency, a load, etc. are detected as a signal, a valve system 63 closes a valve 62 through a translator 64 depending on a service condition a little early than the closed stage of an inlet valve 60, and closing mirror cycle actuation is already carried out. 66 is an exhaust valve and 67 is a cylinder room. A valve 62 and a valve system 63 may be rotary bulbs.

[0009] Drawing 15 is drawing showing the relation between the piston location of the above-mentioned engine, and ** and the opening area of an exhaust valve, an axis of ordinate shows opening area and an axis of abscissa shows a piston location. Among drawing, in Curve A, an exhaust valve 66 and B show an inlet valve 60, and C shows a valve 62.

[0010] As shown in (a) at the time of a low load, the closing motion stage of an inlet valve 60 and a valve 62 is the same, therefore the opening area of an inlet valve 60 serves as a part shown in the hatching section, and an engine performs the usual cycle actuation. At the time of a heavy load, as shown in (b), only S brings forward the closing motion stage of a valve 62. Consequently, the real opening area of an inlet valve 60 serves as a part shown in the hatching section, it means closing an inlet valve 60 early, and a real compression ratio becomes low. Therefore, an engine already serves as closing mirror cycle actuation, and a high increase in power of it becomes possible.

[0011] However, even if according to the above it carries out mirror cycle actuation and closes a valve 62, while the inlet valve 60 is open, the air content of the path 65 which is in the air content of the cylinder room 67 in the middle of an inlet valve 60 and a valve 62 is added, since it increases as volume, the effectiveness which closed the valve 62 in the middle of like an inhalation-of-air line decreases, and the effectiveness which is a mirror cycle is made to fall. Moreover, there is a problem that the pumping loss of increase of inhalation-of-air resistance just before a valve 62 closes, and the air content of a path 65 serving as dead volume, and inhalation of air going in and out occurs.

[0012] This invention was made paying attention to the above-mentioned trouble, and does not have a loss, and it aims at offering the adjustable compression ratio engine which can fully demonstrate the effectiveness which is a mirror cycle.

[0013]

[Means for Solving the Problem] For the above-mentioned purpose achievement, in invention of the 1st of the adjustable compression ratio engine of this invention, it had two or more inlet valves per 1 cylinder, and at least one inlet valve was equipped with the suction system which makes valve timing adjustable by changing the phase of the cam which opens and closes this in the internal combustion engine which opens and closes this inlet valve by the cam formed in two or more cam shafts, respectively.

[0014] In the 2nd invention, it had the suction system which sets up the closed stage of an inlet valve in front of a piston bottom dead point, and can set up the closed stage of at least one inlet

valve near a piston bottom dead point depending on a service condition in said internal combustion engine.

[0015] In the 3rd invention, the closed stage of the inlet valve set up in front of said piston bottom dead point could be 20 degrees - 90 degrees in front of the piston bottom dead point by the crank angle of rotation.

[0016] In the 4th invention, it had the suction system which sets up the closed stage of an inlet valve near a piston bottom dead point, and can set up the closed stage of at least one inlet valve behind a piston bottom dead point depending on a service condition in said internal combustion engine.

[0017] In the 5th invention, the closed stage of the inlet valve which can be set up behind said piston bottom dead point could be 40 degrees - 90 degrees behind the piston bottom dead point by the crank angle of rotation.

[0018]

[Function] According to the above-mentioned configuration, it has two or more inlet valves per 1 cylinder, since the closed stage of the inlet valve of the internal combustion engine which drives by the cam formed in two or more cam shafts, respectively was set as 20 degrees - 90 degrees in front of the piston bottom dead point, a compression ratio can be made low, since the cylinder internal pressure in the end of compression becomes low, allowances are produced by the permission maximum pressure, and a high increase in power becomes possible. And since valve timing of at least one inlet valve is made adjustable and it enabled it to set up the closed stage near a piston bottom dead point depending on a service condition, a compression ratio can be made high by that cause, and good startability and a combustion condition can be secured.

[0019] Or since the closed stage of an inlet valve of said internal combustion engine was set up near the piston bottom dead point, a compression ratio can be made high and good startability and a combustion condition can be secured. And since valve timing of at least one inlet valve is made adjustable and it enabled it to set the closed stage as 40 degrees - 90 degrees behind a piston bottom dead point depending on a service condition, thereby, knocking at the time of comb ******** can be low prevented for a compression ratio.

[0020]

[Example] The example of the adjustable compression ratio engine applied to this invention below is explained in full detail with reference to a drawing.

[0021] Drawing 1 is the flat-surface sectional view of the cylinder head part of the diesel power plant which has two inlet valves and two exhaust valves in a 1 cylinder, and drawing 2 is the side-face sectional view. The cylinder head 1 is equipped with the 1st inlet valve 2, the 2nd inlet valve 3, the 1st exhaust valve 4, the 2nd exhaust valve 5 and the 1st cam shaft 10, and the 2nd cam shaft 20. The cams 11, 12, and 13 the 1st inlet valve 2, the 1st exhaust valve 4, and for 2nd exhaust valve 5 are formed in the 1st cam shaft 10, a cam 12 operates the 1st exhaust valve 4 directly, and cams 11 and 13 operate the 1st inlet valve 2 and the 2nd exhaust valve 5 through rocker arms 14 and 15, respectively. A cam 21 is formed in the 2nd cam shaft 20, and the 2nd inlet valve 3 is operated directly. The 2nd cam shaft 20 can delay the valve timing of the 2nd inlet valve 3 by rotating only the include angle beforehand defined by the driving gear which is not illustrated, and shifting the phase of a cam 21. As for a piston, and 23 and 24, 22 is [an inhalation-of-air path and 25] flueways.

[0022] Below, actuation is explained. Drawing 3 is drawing showing the relation between a motion of the piston 22 at the time of a heavy load, and ** and the opening area of an exhaust valve, an axis of ordinate shows opening area and the axis of abscissa shows the location of a

piston 22. A continuous line is the opening area of one valve, and the thin two-dot chain line shows the total opening area of two valves. A shows an exhaust valve among drawing and B shows an inlet valve. That is, it is begun from before a piston bottom dead point to open the 1st and 2nd exhaust valve 4 and 5, and it is closed near a piston top dead center. And the phase is always the same. The 1st and 2nd inlet valve 2 and 3 is the same, and it is begun from near a piston top dead center to open it, and it closes both phases near 20 degrees - before [a piston bottom dead point] 90 degree.

[0023] It seems that the PV diagram at the time of a heavy load is shown in drawing 4 . Since the 1st and 2nd inlet valve 2 and 3 closes in 1a by a piston 22 starting absorption from 0 in a suction stroke, cylinder internal pressure declines and results in 1b along with an arrow head. It results in 2a through 1b to 1a in a compression stroke, and results [from 2a] in the highest cylinder internal pressure 3 in a heating stroke. It results [from 3] in 4 like an expansion line, results in 4 to 1c in a cooling stroke, and results [from 1c] in 0 like an exhaust air line. That is, since it already becomes a closing mirror cycle and the expansion 1a-1b-1a, and compression are only performed near the end like an inhalation-of-air line, a substantial compression ratio becomes low and the compression ratio at this time is the 11 to 13 neighborhood.

[0024] At the time of starting, drawing 5 is drawing showing the relation between a motion of the piston 22 at the time of a light load, and ** and the opening area of an exhaust valve, it rotates the 2nd cam shaft 20 with a driving gear in this case, changes the phase of a cam 21, delays the closed stage of the 2nd inlet valve 3, and carries out it near a piston bottom dead point. As for the inside B1 of drawing, the 1st inlet valve 2 is shown and B-2 shows the 2nd inlet valve 3. Therefore, in the open stage of an inlet valve, near a piston top dead center and a closed stage serve as near a piston bottom dead point.

[0025] Drawing 6 is a PV diagram at the time of a light load at the time of starting, and, as for an inhalation-of-air line, 0-1, a compression stroke 1-2, the heating stroke 2-3, and an expansion line serve as [3-4, the cooling stroke 4-1, and an exhaust air line] the usual cycle actuation of 1-0. The compression ratio at this time is the 15 to 17 neighborhood.

[0026] Below, a PV diagram explains the difference with the time of a light load at the time of a heavy load and starting. At the time of a heavy load, at the time of starting, (a) is a PV diagram at the time of a light load, and since the compression ratio at the time of a heavy load is as small as 11-13, compression-pressure 2a of (b) of drawing 7 can be lower than 2, a leeway can be given to the engine permission maximum pressure (Pmax) 3, and it can burn [b] many fuels. Consequently, area 1c-1a-2a-3-4 of (b) are larger than area 1-2-3 -4 of (a), namely, a workload will increase, will generate high power and becomes realizable [small and a high power engine]. At the time of starting shown in (a), at the time of a light load, 15-17, and since a compression ratio is large, it can acquire good startability and a combustion situation. And there is no volume useless to an inspired air flow path, and it can perform efficient mirror cycle actuation.

[0027] Drawing 8 is the flat-surface sectional view of the cylinder head part of the gasoline engine equipped with per [1 cylinder / of two each] **, and an exhaust valve, and drawing 9 is a side-face sectional view. The cylinder bed 31 is equipped with the 1st inlet valve 32, the 2nd inlet valve 33, the 1st exhaust valve 34, the 2nd exhaust valve 35 and the 1st cam shaft 40, and the 2nd cam shaft 50. The cams 41, 42, and 43 the 1st inlet valve 32, the 1st exhaust valve 34, and for 2nd exhaust valve 35 are formed in the 1st cam shaft 40, a cam 41 operates the 1st inlet valve 32 through a rocker arm 44, and cams 42 and 43 operate the 1st exhaust valve 34 and the 2nd exhaust valve 35 directly. The cam 51 is formed in the 2nd cam shaft 50, and the 2nd inlet valve 33 is operated directly. The 2nd cam shaft 50 can delay the valve timing of the 2nd inlet

valve by rotating only the include angle beforehand defined by the driving gear which is not illustrated, and shifting the phase of a cam 51. As for a piston, and 53 and 54, 52 is [an inhalation-of-air path and 55] flueways.

[0028] Actuation is explained below. Drawing 10 is drawing showing the relation between a motion of the piston at the time of a light load, and ** and the opening area of an exhaust valve, an axis of ordinate shows opening area and the axis of abscissa shows the location of a piston 52. A continuous line is the opening area of one valve, and the thin two-dot chain line shows the total opening area of two valves. A shows an exhaust valve among drawing and B shows an inlet valve. That is, it is begun from before a piston bottom dead point to open the 1st and 2nd exhaust valve 34 and 35, and it is closed near a piston top dead center. And the phase is always the same. The phase of the 1st inlet valve 32 and the 2nd inlet valve 33 is also the same, and it begins to open from near a piston top dead center, and closes near a piston bottom dead point.

[0029] Drawing 11 is a PV diagram at the time of a light load at the time of starting, and, as for an inhalation-of-air line, 0-1, a compression stroke 1-2, the heating stroke 2-3, and an expansion line perform [3-4, the cooling stroke 4-1, and an exhaust air line] cycle actuation of 1-0. The compression ratio at this time is made into the 11 to 13 neighborhood, startability and thermal efficiency are improved, and they are fuel consumption reduction and CO2. Yield reduction is attained.

[0030] Drawing 12 is drawing showing the relation between a motion of the piston at the time of a heavy load, and ** and the opening area of an exhaust valve, rotates the 2nd cam shaft 50 with the driving gear which is not illustrated in this case, and makes the closed stage of the 2nd inlet valve 33 40 degrees - 90 degrees behind a piston bottom dead point. As for the inside B1 of drawing, the 1st inlet valve 32 is shown and B-2 shows the 2nd inlet valve 33.

[0031] Drawing 13 is a PV diagram at the time of a heavy load, the inhalation of air of the inhalation-of-air line is carried out by 0-1, and according to a compression stroke, by one to 1 d, since the 2nd inlet valve 33 is open, a pressure up is not carried out but the 2nd inlet valve 33 closes by 1d point, a compression stroke serves as 1d-2b. 3-4, the cooling stroke 4-1, and an exhaust air line serve as ****** mirror cycle actuation of 1-0 like heating stroke 2b -3 and an expansion line more nearly henceforth. The compression ratio at this time is the eight to 10 neighborhood, and it prevents generating of knocking at the time of high power while high power generating is possible.

[0032]

[Effect of the Invention] As explained in full detail above, this invention has two or more inlet valves per 1 cylinder. The internal combustion engine which opens and closes an inlet valve by two or more cam shafts, respectively, Since the closed stage of an inlet valve was set as 20 degrees - 90 degrees in front of the piston bottom dead point, the phase of the cam shaft of at least one inlet valve is shifted and the closed stage of an inlet valve was set up near the piston bottom dead point at the time of a light load at the time of starting, At the time of a heavy load, a compression ratio is made small, a high increase in power is made possible, and small and a high power engine can be realized. And at the time of starting, a compression ratio can be enlarged at the time of a light load, and startability and a good combustion condition can be secured.

[0033] Or since the closed stage of an inlet valve of the above-mentioned internal combustion engine was set up near the piston bottom dead point, the phase of the cam shaft of at least one inlet valve is shifted and the closed stage of an inlet valve was set as 40 degrees - 90 degrees behind the piston bottom dead point at the time of a heavy load, at the time of starting, a compression ratio is enlarged at the time of a light load, improvement in startability and thermal

efficiency is aimed at, and fuel consumption is reduced, and it is CO2. Generating can be reduced. And at the time of a heavy load, a compression ratio can be made small, generating of knocking can be prevented, and the efficient adjustable compression ratio engine which does not have dead volume in an inspired air flow path is obtained.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Flat-surface sectional view ****** of the cylinder head part of the diesel power plant of this invention.
[Drawing 2] They are 1 ** and a side-face sectional view.
[Drawing 3] It is drawing showing the relation between a motion of the piston at the time of the heavy load of this engine, and ** and the opening area of an exhaust valve.
[Drawing 4] It is a PV diagram at the time of the heavy load of this engine.
[Drawing 5] It is drawing showing the relation between a motion of the piston at the time of a light load, and ** and the opening area of an exhaust valve at the time of starting of this engine.
[Drawing 6] It is a PV diagram at the time of a light load at the time of starting of this engine.
[Drawing 7] It is drawing which compared the PV diagram with the time of a light load at the time of the heavy load of this engine, and starting.
[Drawing 8] It is the flat-surface sectional view of the cylinder head part of the gasoline engine of this invention.
[Drawing 9] It is a **** side-face sectional view.
[Drawing 10] It is drawing showing the relation between a motion of the piston at the time of a light load, and ** and the opening area of an exhaust valve at the time of starting of this engine.
[Drawing 11] It is a PV diagram at the time of a light load at the time of starting of this engine.
[Drawing 12] It is drawing showing the relation between a motion of the piston at the time of the heavy load of this engine, and ** and the opening area of an exhaust valve.
[Drawing 13] It is a PV diagram at the time of the heavy load of this engine.
[Drawing 14] The former already closes and it is the conceptual diagram of a Miller cycle engine.
[Drawing 15] It is drawing showing the relation between a motion of a **** piston, and ** and the opening area of an exhaust valve.
[Description of Notations]
1 31 [.. 5 The 1st exhaust valve, 35 / .. 10 The 2nd exhaust valve, 40 / .. 20 The 1st cam shaft, 50 / .. The 2nd cam shaft, 14, 15 44 / .. Rocker arm.] .... 2 The cylinder head, 32 .. 3 The 1st inlet valve, 33 .. 4 The 2nd inlet valve, 34

[Translation done.]